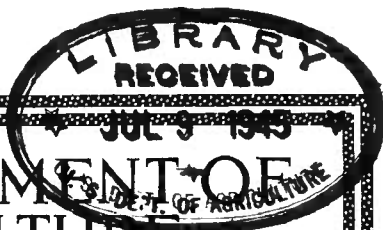


Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

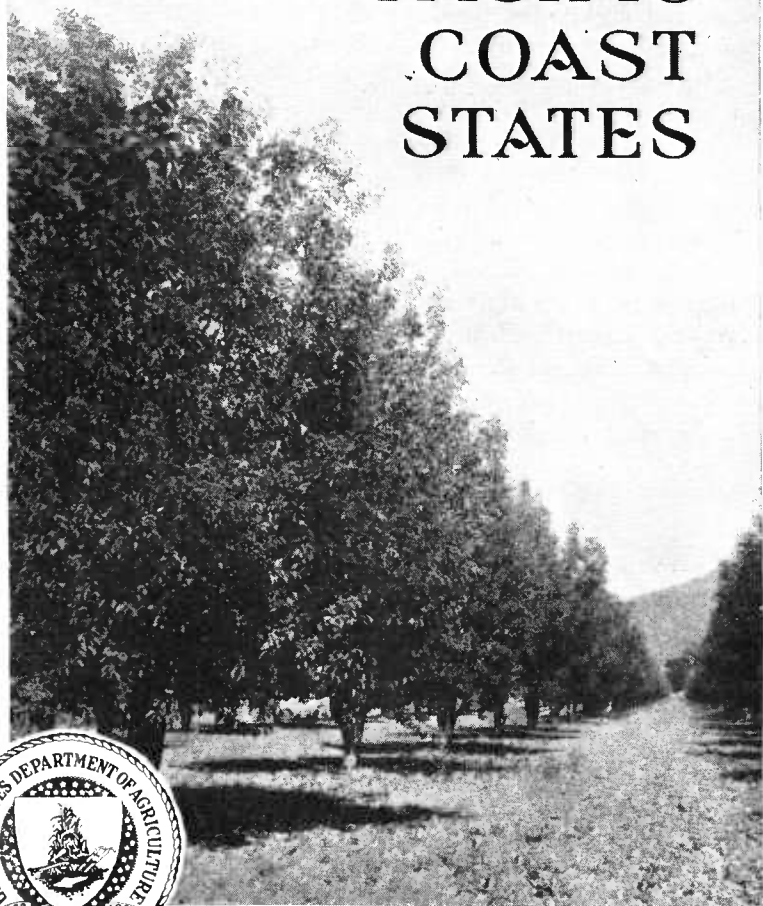
Ag 84F

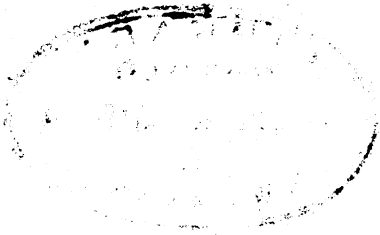


U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1739

PEAR GROWING *in the* PACIFIC COAST STATES





THE PEAR is one of the important deciduous fruit crops of the Pacific coast. Pear growing there dates from the earliest settlement of the country by white men. The varieties grown have largely been imported from Europe.

This bulletin describes the methods of commercial pear growing in the Pacific Coast States, and includes descriptions of the principal varieties, soil-management practices, pruning, and general orchard care. Rootstocks for orchards, the fertilizer requirements of the pear, and pollination of the commercial orchards are discussed. The characteristics of the important pear districts are described in detail. A general picture of production practices and of the present status of the pear industry is presented.

Washington, D. C.

Issued January 1935
Revised May 1940

PEAR GROWING IN THE PACIFIC COAST STATES

By C. F. KINMAN, *pomologist*, and J. R. MAGNESS, *principal pomologist*, *Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry*¹

Contents

	Page		Page.
Introduction.....	1	Fertilization.....	24
Climatic requirements of the pear.....	2	Pollination.....	24
Soils for the pear.....	4	Pruning.....	25
Pear-growing districts.....	4	Pruning the young tree.....	25
The interior valleys of central California.....	5	Pruning the bearing tree.....	28
The valleys of central California lying		Fruit thinning.....	29
between the Coast Range and the Pa-		Pear handling and storage.....	30
cific Ocean.....	13	Insects and diseases.....	30
The interior valleys of western Oregon.....	15	Insects.....	30
The Hood River Valley.....	16	Diseases.....	31
Valleys of central Washington.....	18	Principal pear varieties in the Pacific Coast	
Site for the pear orchard.....	20	States.....	32
Stocks used in propagating pear trees.....	20	The future of pear growing in the Pacific	
Orchard culture and cover crops.....	22	Coast States.....	38

INTRODUCTION

IN THE UNITED STATES the pear reaches a very high degree of perfection in the States west of the Rocky Mountains; production is especially heavy in the three coast States. The varieties grown are almost exclusively those of high quality introduced from Europe. The pear districts are characterized by dry summers with abundant sunshine. Under these conditions fruit production reaches the maximum, yields as high as 30 tons of fruit per acre being sometimes secured in the better orchards. The fruit produced is also of high quality for the variety. The bacterial disease known as pear blight, which limits the production of pears to varieties partially resistant to it in most parts of the United States, can be controlled sufficiently to permit the growing of the choicest varieties in that section.

The pear takes fourth place in importance among the deciduous tree fruits of the Pacific slope, only the apple, peach, and plum ranking above it. Like the other fruits, it has ranked among important commercial fruit crops here for the past half century or more, or since soon after this region began to be generally and extensively developed.

Along with olives, figs, grapes, and other hardy fruits, pears were one of the important crops of the Franciscan monks, who imported them from Europe and planted and cultivated them at the various California missions. This work of the missionaries antedates the second epoch in the history of the pear industry in this region by nearly a century. Only remnants of these orchards, which produced fruit that is considered to be of inferior quality at present, have withstood the neglect to which they have been subjected since the missions were secularized.

¹ The writers are indebted to Dr. W. P. Tufts and Dr. L. D. Davis, of the University of California, for critical review of this bulletin and suggestions as to revision.

The second epoch in pear production started when fruit growing became an important commercial industry in a number of sections of the West, which in California was in the middle of the past century. The general development of this section started about that time. About 20 years later commercial shipments were made in car-load lots. Numerous small pear orchards were established in Oregon and Washington during pioneer days from 1850 to 1880, but the industry did not reach commercial proportions until early in the present century.

CLIMATIC REQUIREMENTS OF THE PEAR

Although the pear will endure a wide range of climatic conditions, its culture for the most part has been restricted to localities that are particularly favorable for pear production. On the Pacific coast the pear is an important commercial crop from south-central California to the Canadian line and on up into British Columbia. The southern limit of commercial pear growing is determined by the prevalence of high winter temperatures. In common with the peach, apple, and other deciduous fruits, the commercial pear varieties grown on the Pacific coast require a considerable period of low temperatures during the winter months to permit them to complete their dormant period and to start off vigorously in the spring. Consequently the pear is not adapted for commercial production in regions where winter temperatures are so mild that the trees do not complete this period before blossoming time.

Most varieties of pears will endure relatively low winter temperatures without much injury. If the trees are fully dormant, temperatures as low as -20° F. usually will do little injury. The wood and buds of the pear are apparently somewhat more subject to injury from low temperatures than are those of apples under the same conditions. On the other hand, the pear is somewhat more resistant to low temperatures than is the peach. In general, pear planting is considered questionable where temperatures lower than -20° to -25° are likely to occur.

In most of the Pacific coast districts irrigation is depended upon for moisture supply, the main exceptions being in northwestern Oregon and western Washington; consequently rainfall does not determine the distribution of pear production. Observations would indicate that where natural rainfall is depended upon for soil moisture, an average of at least 35 inches per year is desirable.

Of extreme importance in the location of a pear orchard is the question of air drainage and freedom from spring frosts. The pear is a relatively early bloomer. If the rest period has become completely broken during the winter the pear normally blooms several days earlier than the apple. The blossoms are about as easily damaged by spring frosts as are those of apples and peaches; thus the hazards from spring frosts are greater with pears than with apples, due to the earlier blooming season. In some parts of the Pacific Northwest it has been found desirable to equip pear orchards with heaters to protect the trees during the blooming season, particularly where orchards are located on lowland where air drainage is not especially good. Because of the adaptability of the pear to fairly heavy soils, orchards have frequently been located on lowland.

The most serious disease factor in connection with pear production is pear blight, caused by the bacterium *Bacillus amylovorus*. On the Pacific coast this disease is most serious in the interior valleys, particularly those of California and southern Oregon, where spring and early summer temperatures are likely to be high. In districts having cooler growing seasons, such as the coastal districts of California, the Willamette and Hood River Valleys of Oregon, and the Puget Sound district of Washington, pears are much less seriously affected by this disease.

Treatments for the disease are primarily surgical. Cutting out affected branches and disinfecting the wounds are common practices in all pear-growing regions. New methods for control are being continually studied. Detailed directions for handling the disease can be obtained from county agents or State experiment station workers in the different districts.

Apparently there is a very definite correlation between climatic conditions and the quality of certain varieties. The Bartlett, which is by far the most important pear variety on the Pacific coast, apparently reaches its highest dessert quality and best shipping and storage quality where temperatures for the 2 months preceding harvesting are high. Grown in the cooler districts, this variety generally tends to ripen relatively quickly after picking and has a marked tendency to break down at the core while still firm and in prime eating condition on the outside. Fruit of this variety grown in hot districts, on the other hand, tends to ripen somewhat more slowly after harvest, remains in prime eating or canning condition for a longer period, and has less tendency to break down at the core while the outside is in good shape. The Bosc, another important variety, also appears to reach its highest dessert quality under relatively high temperature conditions. Other varieties, including Anjou, Hardy, Winter Nelis, and Easter Beurre, are well adapted to cooler conditions and appear to reach equally good quality in the cooler climate of the coastal districts of California and the moderately hot valleys of the Northwest.

The mean summer temperatures at typical points in important Pacific coast pear districts are shown in table 1.

TABLE 1.—Mean growing-season temperatures, by months, in important pear-growing districts in the Pacific Coast States

Station	District	Mean temperatures in—						
		March	April	May	June	July	August	September
		°F.	°F.	°F.	°F.	°F.	°F.	°F.
San Jose	Central California, coastal ..	53.1	56.3	58.5	62.7	66.5	66.1	64.2
Santa Rosa	do	51.2	54.4	57.6	63.0	65.2	64.4	63.8
Auburn	Central California	51.2	56.1	62.4	71.4	77.0	76.0	69.2
Marysville	do	54.3	59.4	64.8	72.8	77.8	76.2	71.9
Sacramento	do	54.3	58.1	63.3	69.4	73.2	72.9	69.3
Upper Lake	do	49.9	54.8	59.6	66.7	73.8	72.7	66.7
Fairmont	Antelope Valley, Calif.	52.1	57.0	63.9	72.3	80.9	79.8	73.0
Medford	Rogue River Valley, Oreg.	46.7	51.6	57.7	65.2	71.8	70.8	63.1
Salem	Willamette Valley, Oreg.	46.3	51.0	56.1	61.6	66.6	66.7	60.9
Hood River	Hood River Valley, Oreg.	43.3	49.9	56.1	61.6	67.4	66.6	59.5
Wenatchee	Wenatchee Valley, Wash.	42.8	51.5	58.8	66.2	73.2	71.6	61.6
Yakima	Yakima Valley, Wash.	44.1	52.5	59.0	66.4	71.4	69.5	61.1
Puyallup	Puget Sound, Wash.	44.8	49.2	54.2	59.6	63.8	62.8	57.7

SOILS FOR THE PEAR

The pear will apparently tolerate a somewhat wider range of soils than most orchard fruits. The trees will thrive on practically all orchard soils, provided they have sufficient moisture and are well drained. They will succeed better on the heavy, sticky clays and adobe soils than almost any other of the commonly grown fruits. Like other fruits, they grow best on deep, fertile loams, and it is on such soils that most of the best trees are found. A clay loam with a well-drained subsoil is generally considered best for them.

Good tree growth cannot be expected on shallow soil of low fertility or on poor soil where the subsoil is waterlogged. Good tree growth and production may be attained even where the water table is fairly high if the soil is fertile and if irrigation furnishes sufficient moisture during the dry summer season. Pear trees do well in the lower portion of the Sacramento River Valley, where the soil is built up by recent deposits of fertile silt loam. In this district the water table is fairly high, but as it supplies moisture during the summer, the trees apparently thrive. On the other hand, the pear is not well adapted to soils having an impervious clay subsoil. Although pear trees thrive on somewhat heavier soil types than most other fruits, good drainage is essential to good growth and productiveness.

Where irrigation is not supplied it is particularly important that the soil be deep, well drained, and retentive of moisture. The summer season in all of the Pacific coast districts is relatively dry. The soil must have a good capacity for holding available moisture, or the trees will suffer as they grow older, unless irrigation is practiced. With deep retentive soils and an abundance of winter rainfall, fairly good production can be secured without irrigation.

PEAR-GROWING DISTRICTS

Because of soil and climatic demands, most pear orchards in the Pacific States are found in restricted localities where the conditions for good production are well supplied. Numerous fruit crops besides pears are grown in these districts, as crop diversification is desired. The prevalence of pear blight has prevented a more general distribution of pear growing in some sections. All three of the States bordering on the Pacific Ocean have a few important centers of pear production, and from these restricted areas come most of the shipments of this fruit. There are two important centers of production in both Washington and Oregon and several in California.

For convenience in discussion, the principal pear-growing districts that are set off by natural geographic boundaries will be considered separately. These districts are widely separated, and each possesses peculiarities that make pear growing attractive. They are as follows: (1) Interior valleys of central California, including the smaller tributary valleys and adjacent slopes and foothills; (2) coastal districts of central California; (3) interior valleys of western Oregon; (4) the Hood River Valley; and (5) the Yakima and Wenatchee Valleys of central Washington.

The acreage devoted to pears in the principal pear-growing sections is given in tables 2 to 4.

Outline maps of California, Oregon, and Washington (figs. 1 to 3) show the relative position of the pear-growing centers.

THE INTERIOR VALLEYS OF CENTRAL CALIFORNIA

Pear culture in the interior valleys of central California is mainly restricted to a few localities, although scattered commercial orchards and occasional home-orchard trees are found throughout almost the entire territory. Nearly one-half of the pear trees in California are

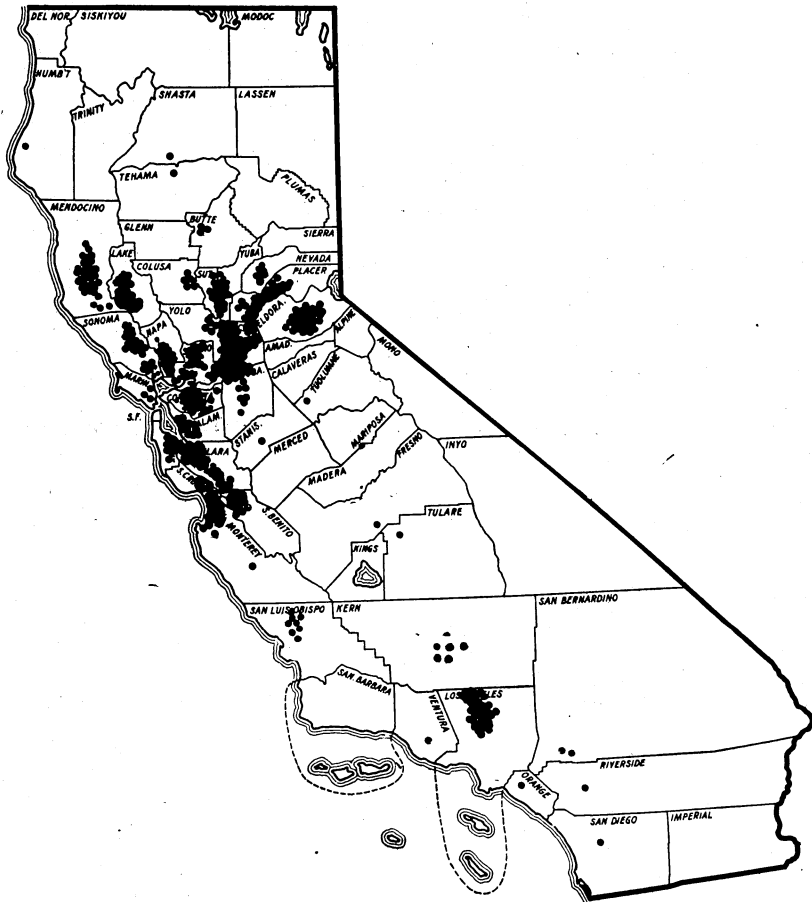


FIGURE 1.—Distribution of pear growing in California; each dot represents 100 acres of pears.

growing in this district. The principal pear-producing sections here include (1) the bottom lands of the Sacramento Valley, (2) the foothills to the east of the Sacramento Valley, (3) the valleys to the northwest of the lower portion of the Sacramento Valley, and (4) the Clearlake section of Lake County and the Ukiah section of Mendocino County. All these are important pear-producing sections, and all are well adapted to the production of the Bartlett variety.

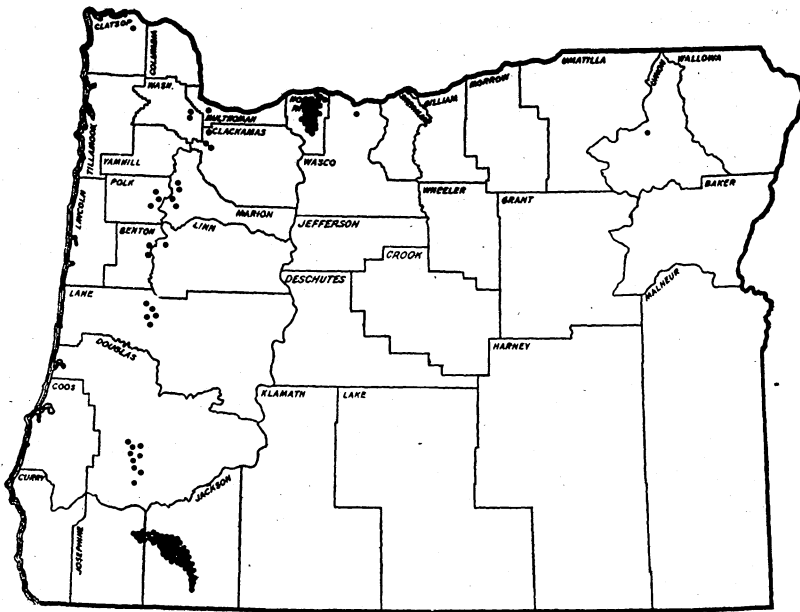


FIGURE 2.—Distribution of pear growing in Oregon; each dot represents 100 acres of pears.

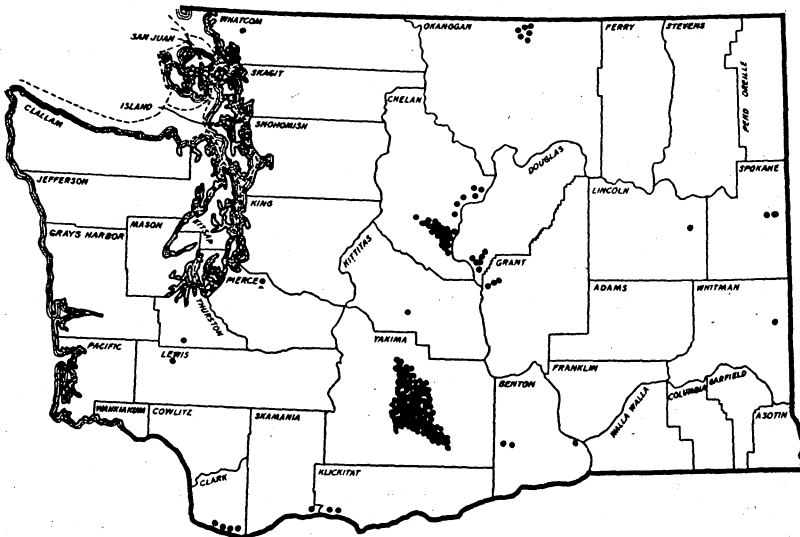


FIGURE 3.—Distribution of pear growing in Washington; each dot represents 100 acres of pears.

TABLE 2.—*Estimated acreage of pears in California by counties containing over 2,000 acres of pears, and total acreage for the State, 1937¹*

County	Non-bearing trees	Bearing trees	Total	County	Non-bearing trees	Bearing trees	Total
	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>		<i>Acres</i>	<i>Acres</i>	<i>Acres</i>
Santa Clara.....	797	6,630	7,427	Sonoma.....	193	3,575	3,768
Placer.....	806	5,837	6,643	Solano.....	251	3,455	3,706
Sacramento.....	432	4,923	5,355	Contra Costa.....	117	2,684	2,801
Lake.....	626	4,657	5,283	Napa.....	90	2,084	2,174
Eldorado.....	445	3,971	4,416	Other counties.....	787	12,029	12,816
Mendocino.....	244	3,917	4,161	Total.....	4,788	53,762	58,550

¹ Compiled from acreage estimates, California fruit and nut crops as of 1937, published Aug. 1, 1938.TABLE 3.—*Acreage of principal varieties of pears in California¹ (Bartlett for 1937, other varieties for 1936)*

Variety	Non-bearing trees	Bearing trees	Total	Variety	Non-bearing trees	Bearing trees	Total
	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>		<i>Acres</i>	<i>Acres</i>	<i>Acres</i>
Anjou.....	97	483	580	Hardy.....	568	2,205	2,773
Bartlett.....	3,533	45,486	49,019	Winter Nelis.....	197	1,613	1,810
Bosc.....	149	1,183	1,332	Miscellaneous.....	256	2,001	2,257
Comice.....	119	815	934				

¹ Compiled from California fruit and nut acreage survey, 1936, and acreage estimates, California fruit and nut crops as of 1937.TABLE 4.—*Estimated acreage of principal varieties of pears in certain counties of Oregon¹ and Washington²*

Variety	Jackson County, Oreg.			Hood River County, Oreg.		
	Trees 1 through 5 years of age	Trees 6 years of age and over	Total	Trees 1 through 5 years of age	Trees 6 years of age and over	Total
	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>
Anjou.....	305.5	2,470.9	2,776.4	664.8	1,488.1	2,152.9
Bartlett.....	219.1	3,604.9	3,824.0	515.0	783.0	1,298.0
Bosc.....	123.6	2,522.5	2,646.1	39.0	305.0	344.0
Miscellaneous.....	181.5	1,474.4	1,655.9	110.0	192.0	302.0
Total.....	829.7	10,072.7	10,902.4	1,328.8	2,768.1	4,096.9

Variety	Yakima County, Wash.			Chelan County, Wash.		
	Trees 1 through 5 years of age	Trees 6 years of age and over	Total	Trees 1 through 5 years of age	Trees 6 years of age and over	Total
	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>
Anjou.....	305.6	819.0	1,124.6	302.3	804.9	1,107.2
Bartlett.....	1,137.7	9,631.5	10,769.2	176.9	1,446.9	1,623.8
Bosc.....	35.3	749.7	785.0	15.4	191.4	206.8
Winter Nelis.....	47.9	1,368.7	1,416.6	14.6	14.6	29.2
Miscellaneous.....	20.3	276.7	297.0	11.1	146.5	157.6
Total.....	1,546.8	12,845.6	14,392.4	505.7	2,604.3	3,110.0

¹ Compiled from U. S. Dept. Agr. special Pacific Northwest fruit and berry survey, Oregon, September 1937.² Compiled from U. S. Dept. Agr. special Pacific Northwest fruit and berry survey, Washington, January 1938.

Bottom Lands of the Sacramento Valley

The bottom lands of the Sacramento Valley constitute one of the most important pear-growing localities of the Pacific slope. Between the cities of Sacramento and Isleton, pear culture is the most important fruit industry. Practically all the trees of this locality are found in the region near the river (fig. 4).

The soils devoted to pear culture in the lower Sacramento River bottom section for the most part are sedimentary and of recent origin, the sedimentary soil having been deposited over a layer of peat. In some places the overflow from the river has added to the depth of the soil since the early orchards were established. In recent years the construction of levees has prevented the river from overflowing. The land in this locality, which was built up by the overflowing of the river, is a dark, open, friable, warm loam. Contrary to the belief of

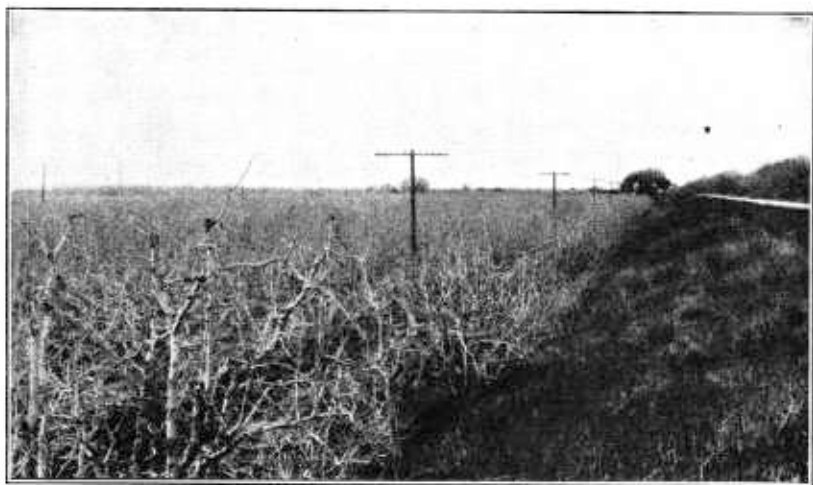


FIGURE 4.—A typical pear-orchard scene in the lower Sacramento River Valley during the dormant season. A portion of the river levee may be seen at the right.

some that only heavy soils are suitable for pears, the Bartlett, which is grown almost to the exclusion of other varieties, reaches a high degree of excellence here both for dessert and for canning purposes. The layer of surface sedimentary soil becomes shallow as the lower portion of this section is approached and also as the distance from the river channel increases. This condition prevails also along the numerous slews that depart from the river and meander through the adjacent lowlands. As these slews reunite with the river or with one another, numerous islands are formed. In many places in this section, known as the Sacramento delta or island district, the layer of sedimentary soil is too shallow for more than a fringe a few tree rows wide along the river or slews, though at other points the depth of this soil permits of extensive orchards (fig. 5).

Beneath the stratum of fertile alluvial soil in this delta region is a bed of peat ranging from a few to many inches in thickness. Water

passes through this material rapidly, and it therefore affords excellent drainage for the higher lands. On the other hand, artificial drainage must be provided for the lower land at the center of the islands; this is accomplished by digging large open ditches. One ditch may provide drainage for a wide area, because of the ready movement of the subsurface water.

Cherries, peaches, plums, and other tree fruits are also found on the higher soils along the levees in this district and provide for the desired crop diversification. On the higher, deeper, better-drained portions that border the river in the northern part of this section, these crops become proportionately more important. All orchards of this section are equipped for irrigation. Water from the river is easily and cheaply secured by means of pumps beside the river and pipes through the river levee.



FIGURE 5.—Old Bartlett trees in the lower Sacramento River Valley. Much of the annual growth has been removed by pruning during the winter. The river levee may be seen at the right.

As in most other localities of California where pears are grown, the coldest weather brings frequent frosts but only occasional light freezes. A large part of the pear-producing acreage of this section lies within the area where summers are moderately hot, although tempered to some extent by cool breezes from San Francisco Bay.

Pears in this section mature early, the first Bartlett shipments from the State usually originating here. The first shipments normally are forwarded in late June or early July, and the fruit moves to eastern markets for approximately 6 weeks. A large part of the late-harvested fruit is canned.

The Foothills East of the Sacramento Valley

In the second portion of the interior valleys of central California, the foothills east of the Sacramento Valley, most of the pears are

found in Placer, Eldorado, and Nevada Counties, with centers in the Newcastle-Auburn district of Placer County, near Placerville, in Eldorado County, and in the Grass Valley-Nevada City district of Nevada County. More than 12,000 acres are planted to pears in these districts, nearly nine-tenths of which are of bearing age. All of these districts are in the rolling foothill section, the highest reaching an elevation of about 3,500 feet. The Bartlett is by far the most important variety. This variety reaches a high degree of perfection for dessert purposes and attains a more colorful red blush than is common in most other pear-growing districts. It carries well to market, but on hillsides or where the soil is not deep it is usually smaller than the best pears from orchards on the deep soils of the river bottoms. The pears of the Penryn-Auburn section of this district, which has much less elevation than the remainder of the district, ripen at a time when they compete with river pears of the same varieties. The harvest in the Placerville-Grass Valley-Nevada City districts is considerably later than in the river bottom, where the heaviest shipments originate; therefore fruit from these districts has an advantage in arriving on the market after peak shipments are past. Bosc, Winter Nelis, and other winter pears are minor commercial varieties in this section.

The trees in the poorer soils of these localities for the most part are not large, and the yield is not so heavy as on the deep bottom lands. Because of the late ripening of the fruit, its high shipping and dessert quality, and excellent appearance, much of the output is shipped fresh, although some of it is canned. All the orchards are under irrigation.

Much of the soil in this section, particularly in the Loomis-Auburn district, is derived from the weathering of granite bedrock and is open, easily worked, fertile, and well-drained, but low in organic matter. It is several feet in depth in some places, but in others it is shallow, and outcroppings of granite are common. The drainage water from the higher soils accumulates at low levels following rains and irrigations, and causes areas varying in size from those large enough for only a few trees to those of several acres in extent, where the soil water is too excessive for the satisfactory growth of most orchard trees. Many of these places are planted to pears; in others, especially in the higher parts, pear growing is the main industry, and there the deepest and best soils are used for this purpose. In the Placerville-Camino district of Placer County, pears are planted mostly on soils classified as Aiken clay loam. This is a residual soil derived from disintegrating schist rocks. It is a red, friable clay loam of good depth and contains a moderate amount of organic matter.

In the higher localities the summers are hot, but somewhat shorter than along the Sacramento River or the districts lower in the foothills, and the pear blossoms are sometimes injured by frost. The blossoms open later in the spring, and the fruit-ripening time comes later in the summer than in the river section. The fruit attains a distinct blush.

The Valleys to the Northwest of the Lower Portion of the Sacramento Valley

A third portion of the interior valleys of central California includes the Vaca Valley, northwest of the lower Sacramento River Valley. The district near Fairfield, in Solano County, although belonging to this geographical section, could be included in the coastal district, since the summer temperatures there are more comparable to those of that district. The Bartlett is the principal variety and most of the fruit is shipped fresh. There is but little water available for irrigation. In the Vaca Valley of Solano County the summers are hot and advance rapidly. The soil there is a very deep, fertile, friable loam, and the trees are thrifty, but on account of lack of moisture they do not make a rapid growth, and the tonnage of fruit produced is only moderate. This tardiness of growth provides unfavorable conditions for pear-blight development. Some

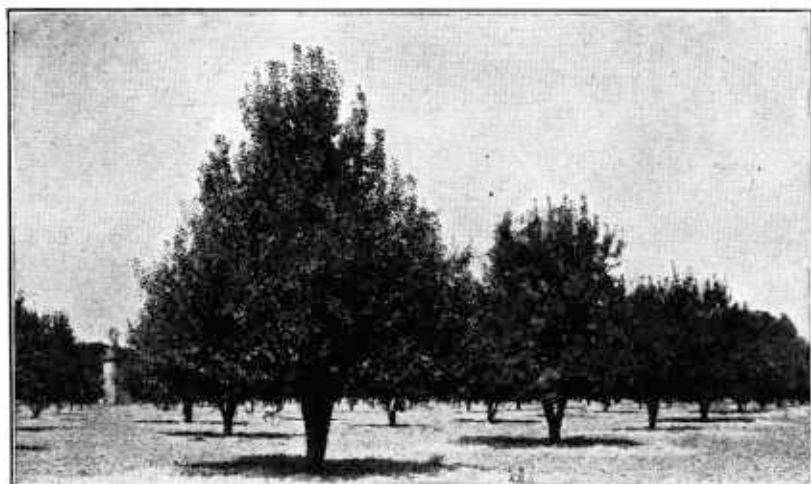


FIGURE 6.—A 40-year-old Bartlett orchard near Clearlake, Calif. The trees are 40 feet apart, and they produce heavy crops of fruit.

of the pear orchards are old, and there are but few new plantings, as most of the available orchard lands in this valley have been planted.

The Clearlake District of Lake County and Ukiah District of Mendocino County

The fourth center of production in the interior valleys of central California includes the Clearlake district about Kelseyville and Upper Lake, both in Lake County, and Ukiah, in Mendocino County. Lake County has over 5,000 acres and Mendocino County has over 4,000 acres, of which about nine-tenths are of bearing age (1937). Near Clearlake there are a number of old orchards (figs. 6 and 7), but following the time of their planting the acreage devoted to pears increased only slowly until more recently when there was a sudden expansion of the industry in this locality. With the improvement of the State highway over a mountain range connecting the Clearlake district with the railroad in 1920 came the general expansion of the pear industry. Previous to this time transporta-

tion was difficult and expensive, and but little fruit was shipped fresh.

There is considerable variation in the soil in this locality. In some places it is a deep and easily tilled loam, but the larger areas are for the most part a rather heavy black clay that gradually slopes to the level of the lake. The soil is very fertile but should be worked only at the proper time. Until recently only a few orchards were irrigated, but now the practice is increasing. The water is secured largely from wells. The Bartlett is grown practically to the exclusion of other varieties. Trees grow well, bear regularly, and the fruit reaches large size and is of good quality and an attractive color. The trees blossom later and the fruit ripens later than in the principal sections of production in the Sacramento Valley. The



FIGURE 7.—An 18-year-old Bartlett pear orchard on deep, fertile, irrigated land near Kelseyville, Calif. (Photographed in June.)

fruit, therefore, reaches the market after the heavy shipments from that district have been sold. The high temperatures that prevail in the Clearlake district as the pear-ripening season is approached permit the fruit to attain excellent shipping quality.

Before the improvement of the State highway, which connects this locality with the railroad, much of the pear crop was dried. The hot, dry summers are suitable both for maturing the fruit evenly so that it does not break down in the center upon ripening and for drying it in the open inexpensively. Owing to their large size and high quality, dried pears from Lake County are the standard of excellence for this product. With improved transportation facilities, a much larger part of the crop is shipped fresh or goes to canneries, and the grower has these additional possibilities of disposing of his fruit.

THE VALLEYS OF CENTRAL CALIFORNIA LYING BETWEEN THE COAST RANGE AND THE PACIFIC OCEAN

The district lying between the Coast Range and the Pacific Ocean includes the counties adjacent to San Francisco Bay, Solano County, and also Monterey and San Benito Counties, farther south. The principal pear-growing localities of this district are the low coastal plains adjoining San Francisco Bay in Santa Clara, Alameda, and Contra Costa Counties, the Napa Valley of Napa County, and the Sonoma Valley of Sonoma County.

In all these sections the temperatures are tempered by ocean breezes, so that the summers are much cooler than in the interior valleys. The lower summer temperatures are less favorable for the development of blight than those of the interior pear-growing districts. This also results in a later ripening period. In this district the Bartlett is of less desirable quality for distant shipment than in districts where there is a period of a few weeks of high temperatures previous to the fruit harvest. This is one of the oldest centers of commercial pear culture in California, and some of the orchards planted in the middle of the last century are still cultivated, though many of the varieties planted at that time have been grafted over to more desirable ones (fig. 8). At present there are more varieties grown commercially in this district than in other parts of California. They include the Bartlett, Hardy, Winter Nelis, Bosc, Anjou, Easter Beurre, Clairgeau, Comice, and others. Of late years Bartlett and Hardy have been the most popular for planting. The Bartlett is grown mostly for canning, and the later-ripening varieties for shipping fresh.

In the sections adjoining San Francisco Bay many of the pear orchards are at a low elevation and near the bay. The soil here is a dark, moderately heavy clay that is fertile but sticky when wet, and hard when dry. Care must be exercised to work it only when in proper condition. Farther back from the bay and on higher elevations the soil becomes more loamy and open and is well adapted to the culture of other deciduous fruits and nuts, and much of it has been planted to prunes, apricots, cherries, and Persian (English) walnuts. Occasional pear orchards have been planted on this more loamy land also, and such orchards generally have good tree growth and production. Practically all the orchards of this district are under irrigation. Santa Clara County ranked first in total pear acreage in California in 1937 with 7,427 acres.

Near San Juan and in the Carmel Valley in Monterey County, the pear is the principal fruit grown, although the acreage is not large. In the former locality the soil is of a deep, fertile, and rather heavy type, and excellent tree growth and fruit production are obtained. The late-ripening varieties are grown almost exclusively, and the fruit is shipped fresh (fig. 9). The pear-growing center in the Carmel Valley is a narrow strip of river-bottom land a few miles inland from the ocean. Late-ripening varieties are the principal ones grown. The soil is a deep, fertile, open loam, and trees thrive and bear well. Because of the small size of this valley, the land suitable for orcharding is very limited.

Throughout this coastal area, as well as in southern regions in California, the Bartlett pears tend to lose their characteristic pyriform shape. Under extreme conditions the radial diameter of the

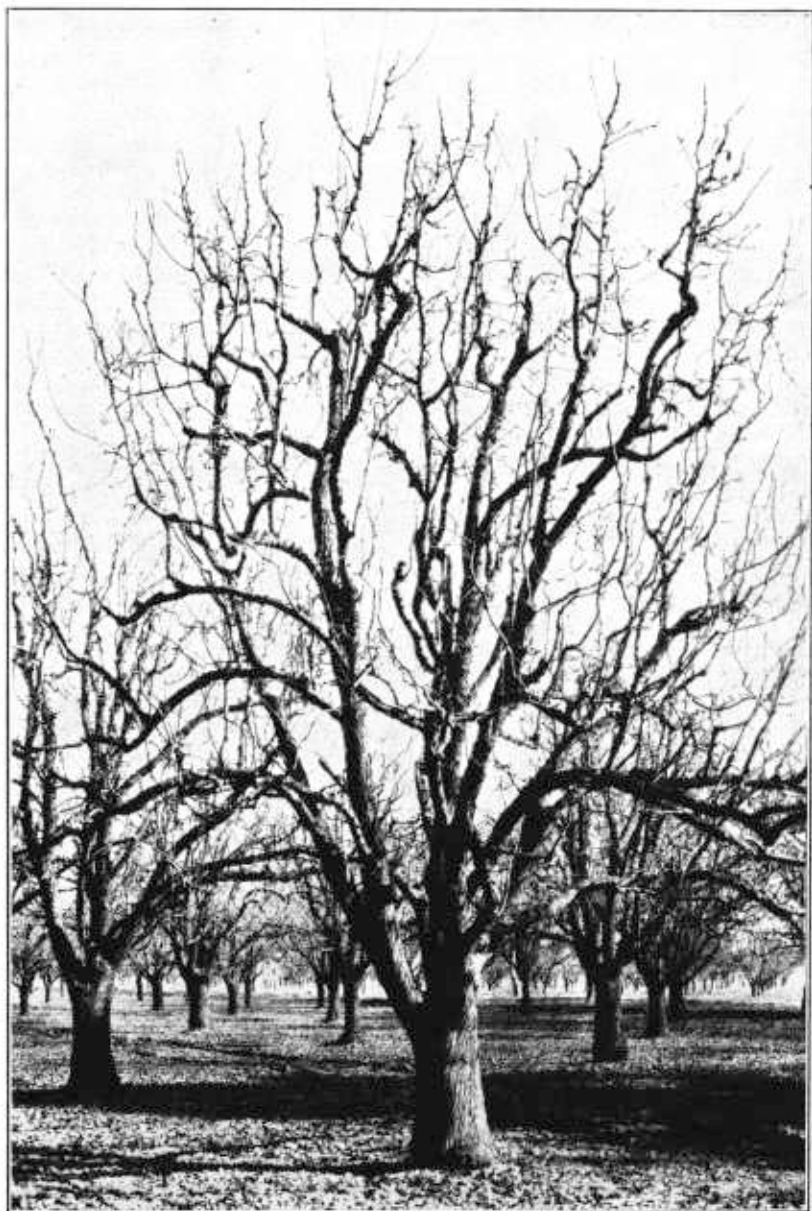


FIGURE 8.—Some 56-year-old Hardy trees on French roots. (Santa Clara, Calif. Photographed in February.)

fruit almost equals its length, and the fruit is not acceptable for canning. This condition constitutes a serious problem in coastal districts where the crop is largely used for canning. Tufts and Hansen² have shown that fruit from the more northern districts averages longest in proportion to diameter, the ratios varying from around 1.2 to 1 in central California to around 1.48 to 1 in Yakima, Wash.



FIGURE 9.—A 10-year-old Hardy orchard near San Juan, Calif. The trees were planted 24 by 24 feet. They are on quince roots. (Photographed in April.)

THE INTERIOR VALLEYS OF WESTERN OREGON

The principal pear plantings in western Oregon are found in the Rogue River Valley, and there are limited plantings in the Umpqua and Willamette River Valleys and their tributaries. The Rogue River Valley district, lying west of the center of the State and almost touching the California line, is the principal center of production in Oregon, although the Hood River district is also an important producing center. The Rogue River Valley district ranges from 1,874 feet above sea level at Ashland on the south to 935 feet at Grants Pass on the north, and is almost entirely surrounded by mountains. The city of Medford, the principal shipping point, is situated near the center of this district. There are about 12,000 acres of pears in this district. Large plantings were made early in this century, although about half of the present acreage has been planted since 1912. A considerable portion of the present acreage was planted after water for irrigation was made available between 1917 and 1920. The ravages of pear blight have been very severe in this valley.

Freezing temperatures occur throughout the valley in winter. Spring frosts are frequent, particularly on the floor of the valley,

² Variations in Shape of Bartlett Pears, by W. P. Tufts and C. J. Hansen, Amer. Soc. Hort. Sci. Proc. (1931) 28: 627-633. 1932.

and orchards must be protected by heating, which is general and efficient. The lower slopes surrounding the valley are seldom visited by damaging frosts during blossoming time, owing to the good air drainage. The summers are hot and dry and well-suited to the ripening of pears. The rainfall from September to the following May totals 15 to 25 inches per year and is supplemented by irrigation during the dry season in all but a small percentage of the orchards. Much of the soil of this district is a rather heavy adobe and is better suited to pears than to other tree fruits. Although the soil is fertile, much of it is underlain by a stratum of hardpan, at a depth varying from a few inches in some of the upland places to several feet in the bottom lands. In portions of the district, a high-water table presents a serious problem, requiring community drainage efforts. On the deeper soils trees grow rapidly; on the shallower ones wood growth is rather slow. The slow-growing trees are less susceptible to blight, but production is also much less.

Bartlett, Anjou, and Bosc are the varieties most extensively planted. Winter Nelis, Comice, Howell, and a few minor varieties are grown in commercial quantities also and range in importance in about the order named. The Bartlett is still the most important variety, and recent plantings have been largely of this variety and Anjou. The Bartlett produced here is of high dessert and canning quality and ships well. Most orchards of Bartlett are in bearing. The Bosc blights badly here, but bears heavily, and the fruit is of good size, quality, and appearance. The popularity of Anjou is increasing, owing to its excellence in size, appearance, and dessert and storage quality. The Anjou tree is the most blight-resistant of the varieties extensively grown (fig. 10). The fact that the trees are late in coming into bearing and have generally been less productive than Bartlett and Bosc has prevented the planting of a much larger acreage. Winter Nelis has been a satisfactory variety where planted on the deeper soils and well irrigated, but in unirrigated orchards and on poor soils the fruit is often small.

In the Umpqua and Willamette River Valleys pears are grown commercially but are not included among the most important fruits. Summer temperatures in these valleys are lower than in the Rogue River Valley and not warm enough for the best development of most pear varieties. With the lower temperatures of these valleys there is almost no loss from blight. Winter injury has at times been serious in the Willamette Valley, causing the loss of many orchards.

THE HOOD RIVER VALLEY

The Hood River Valley, which lies about 150 miles from the coast and at the extreme northern boundary of the State, is the only other district in Oregon where pear growing is an important commercial industry. There are over 4,000 acres devoted to this fruit, of which two-thirds of the trees are of bearing age. Although the apple is the most important fruit grown in this district, pears are being planted more than apples at the present time.

Anjou, Bartlett, and Bosc are the principal varieties grown. Of the trees in bearing, a little over half are of the Anjou variety, with Bartlett, Bosc, Flemish Beauty, and minor varieties following in importance in about the order named. In the acreage not in

bearing the Anjou leads in importance, half of this acreage being of this variety. New plantings of Bartlett are slightly less than those of Anjou. There are almost no new plantings of Bosc. A few new plantings are found of the Easter Beurre variety, made because it is considered satisfactory as a pollinizer for Anjou. The popularity of the Anjou and Bosc is due to the high quality and appearance of the fruit, and their good keeping qualities when placed in cold storage. In this district the Bartlett is used both for canning and fresh shipment.

The soils of this district vary considerably in depth and texture but not sufficiently to restrict the planting to given soil types, and pear orchards are found scattered throughout the fruit-growing portion of the valley. The surface soils are for the most part sandy or



FIGURE 10.—A typical Anjou pear orchard on adobe soil in the Rogue River Valley, Medford, Oreg. (Photographed in July.)

silty loam, very open, and in many places rather shallow. Water passes through these soils rapidly. The subsoils are composed of about the same materials as the upper soils in many places; some of them are very open, permitting good or sometimes excessive drainage; others are so compact that the downward movement of water through them is almost entirely prevented.

The rainfall during the summer is very light, and this, with the rather poor water-holding capacity of the soil, makes irrigation necessary in most orchards. With the very open and well-drained soils in one locality and compact subsoils commonly known as hardpan in another, careful observation and caution are necessary in adopting a wise irrigation program. Although pear roots will endure excessive soil moisture better than those of many tree fruits, they will

not thrive in waterlogged soils in summer. Therefore, where a hard substratum comes too near the surface, care in drainage is necessary to prevent an accumulation of seepage water from higher levels.

As the soil has a high sand and silt content and the surface layer suited to root growth is shallow in some places, there is need for increasing and maintaining the humus content. Cover crops, either cultivated plants or native vegetation, are grown for this purpose in most orchards. Alfalfa and sweetclover are the crops most commonly grown.

With the type of soil as described and the high rate at which succulent cover crops take water, there is likely to be a rapid change of moisture content in the soil, which requires special care to prevent drying out excessively between irrigations.

Winter injury constitutes a greater hazard to pear production in this district than in other important pear sections of the Pacific coast. Winters are generally mild, but occasional severe cold, with the trees not thoroughly hardened, has resulted in serious damage, particularly to young trees. Pear blight has not been serious in the Hood River Valley.

VALLEYS OF CENTRAL WASHINGTON

Two irrigated districts, one surrounding Yakima and the other centering about Wenatchee, are the only important pear-producing districts of central Washington. Pear orchards are found scattered throughout these large fruit-growing belts. In the older orchards, pears and apples were often interplanted. In both districts the soil is deep and fertile and well-adapted to pear growing. As the rainfall is very sparse and occurs during the winter, all orchards are under irrigation. There is good tree growth and production in these districts, and blight, while troublesome in some years, apparently is not so severe a menace as in the Rogue River Valley and the interior valley sections of California. This, with the naturally good tree growth and production, makes pear growing attractive.

In the Yakima district commercial pear planting started about 1900, as did the commercial apple industry, but pear growing progressed slowly in comparison with apple growing (fig. 11). About one-tenth of the pears, which total over 14,000 acres, were under 5 years of age in 1936.

Of the several varieties grown commercially in this district, the plantings of Bartlett are over seven times as extensive as those of any other. Winter Nelis comes next in the number of trees planted with practically all of them of bearing age. Of late years the interest in the Anjou has increased considerably. Other varieties of lesser importance are Comice and Flemish Beauty.

In the Wenatchee district, pears, with 4,437 acres in 1936, come next after apples in importance. There are as many Bartlett trees as trees of all other varieties combined. About four-fifths of the nearly 1,500 acres of Anjou trees were over 6 years old at that time. Of the Bosc, which occupies third place in number of growing trees, nearly all trees were 6 years of age in 1936. Nearly all trees of the rather small acreage of Flemish Beauty and Winter Nelis are in bearing. The new plantings of a few varieties indicate the popu-



FIGURE 11.—Forty-year-old Anjou pear trees on deep, open soil in the Yakima Valley of Washington. (Sawyer, Wash.)

larity of the pear as a commercial fruit in this district at the present time. In both the Yakima and Wenatchee districts the Bartlett attains good size, shape, and quality for canning. The variety reaches the extreme of pyriform shape or length in proportion to width in these northern districts. This long type of pear is very popular with canners.

With fertile, deep soil and abundant water for irrigation, pear trees in both the Yakima and Wenatchee districts are vigorous and productive. With abundant cold-storage facilities in the district, much of the Bartlett crop is held in cold storage and sent to canneries as they demand it. Some of it is placed on the fresh-fruit market after the California movement is over.

SITE FOR THE PEAR ORCHARD

From the standpoint of air drainage for frost protection, the slopes of rolling lands are preferable for pears; but for the purpose of crop diversification these places are often planted in California, at least, to fruits which blossom earlier than the pear and are therefore more susceptible to frost injury at blossom time. This leaves the lower places for the pear and sometimes makes artificial frost-prevention practices necessary. The slopes afford better soil drainage also, but here again the pear is more resistant to faulty growing conditions than are other fruits and will endure considerably more soil moisture provided such moisture is not stagnant and the soil is fertile. The pear likes a soil of good depth also, but will often succeed where the water table is too high for most other deciduous tree fruits. In the principal pear-growing districts of California and Oregon, a considerable number of the pear trees have been planted on sites where at least during the winter and spring the soil moisture is somewhat in excess of that considered ideal for the best tree growth.

As the pear fruit is easily injured in handling, the availability and condition of roads over which it may be taken to the packing house and shipping point are important. Fortunately, most of the pear-growing localities in the Pacific Coast States are well supplied with good roads.

STOCKS USED IN PROPAGATING PEAR TREES

The determination of the most suitable rootstocks for propagating pear trees has received a great deal of study. The most widely used stock is the European wild pear (*Pyrus communis*), commonly called French pear, and were it not for its susceptibility to pear blight, this stock would be almost ideal. It is a vigorous grower, withstands both drought and excessive soil moisture exceedingly well, and gives satisfaction on a wide variety of soils. In respect to its adaptability to a wide range of soils and climatic conditions, it is one of the most remarkable of cultivated plants. It is also considered one of the most resistant to oakroot fungus among those used for common fruit trees. This species is very susceptible to blight, however, and this disease is often disastrous to the orchard. The French root not only takes blight readily and proves to be an excellent medium for the development of the disease but also tends to produce suckers, thereby providing a convenient entrance to the

root for blight. The suckers often appear in large numbers, coming up well out under the branches, as well as near the trunk. It is the common practice to remove this growth each year, to reduce the chances for blight infection. Except where small trees for close planting are desired, the French stock, even with its susceptibility to the dreaded pear blight, appears to be the best stock now available for general planting and at the present time is being used almost to the exclusion of others.

For a number of years the Japanese stock (*Pyrus serotina*) was planted extensively, but for the past few years its popularity has been decreasing. It was chosen for its resistance to blight and woolly aphis, and also because of its vigorous growth on open soils. Its performance, following its general distribution in pear-growing localities, has demonstrated that it is considerably more resistant to

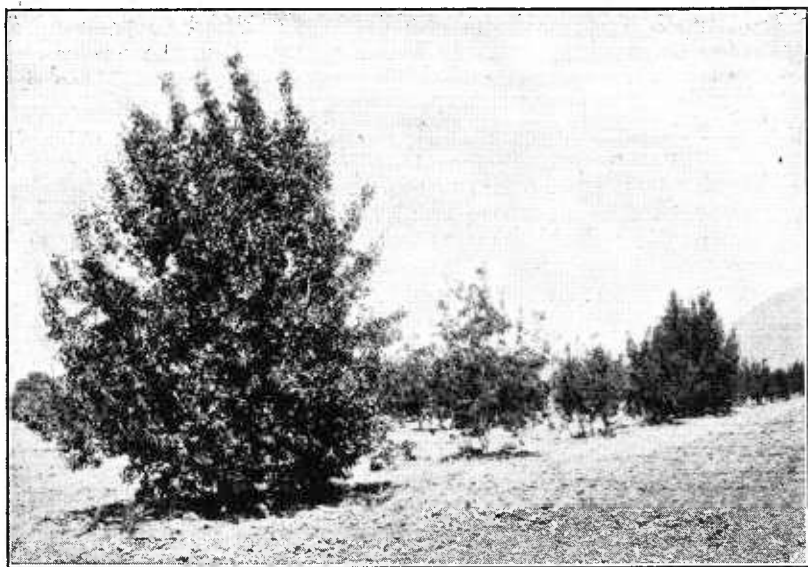


FIGURE 12.—A Bartlett pear orchard on very heavy adobe soil. The two large trees are on French roots and the others on Japanese roots. All trees are the same age. (Kelseyville, Calif., photographed in June.)

pear blight than the French species and that it grows well in open, well-drained soil, but that it produces unsatisfactory trees when planted on heavy, wet, or shallow soil (fig. 12). It is blamed in California for the disease known as black end, or hard end, which has been so disastrous in many orchards. This disease manifests itself in a deforming and blackening of the apex of the fruit, thereby rendering it unsalable. It has appeared almost exclusively on trees with Japanese roots. On soils that are not satisfactory for good tree growth, the loss from black end is often more pronounced than on open, fertile soils where the trees grow well. The black end trouble has caused many orchards in California to be removed, and during the last few years it has caused considerable loss in parts of the Northwest. Some entire orchards are being pulled because of it.

In the hope of improving the growth of unsatisfactory trees and of correcting the condition that results in black end fruit, a number of growers have inarched their trees that are on Japanese roots with French seedlings, but thus far the results of their work have not been sufficiently beneficial to warrant its commercial recommendation.

Other oriental pear stocks, notably *Pyrus calleryana* and *P. ussuriensis*, have been used in a number of orchards, and the seedlings of the former are considered worthy of extended trial by some orchardists and experimenters. The suitability of *P. calleryana* for cold regions is questionable, as there is some evidence that it is more subject to winter injury than is the French root. The planting of *P. ussuriensis* has been discontinued because it did not prove immune to blight and because of the prevalence of the black end disease on fruit produced by trees propagated on it.

Where the soil is shallow but otherwise adapted to pear culture or where close planting or early fruiting is desired, the quince stock is used, as it has a somewhat dwarfing effect on the top. The principal acreage planted on this stock is found in the San Francisco Bay district. As the trees on this stock come to fruiting early and more trees may be planted per acre than if standard stocks were used, heavier yields per acre may be realized for a number of years after the orchard is planted. The semidwarfing of the tree, causing early fruiting, is a decided advantage if the pear is to be used as an intercrop with other fruit. It is preferable to double-work most varieties when grafting on quince.

Extensive projects for developing a satisfactory pear stock that is resistant to blight, as well as extensive searchings of the present material for one, have been under way for a number of years. One stock that has been found promising is a variety of French pear known as Old Home. It is hoped that this variety, which is very resistant to blight, may produce blight-resistant seedlings also and therefore furnish a satisfactory stock.

ORCHARD CULTURE AND COVER CROPS

In the northern districts, including particularly Wenatchee and Yakima, Wash., and Hood River, Oreg., where an abundance of water for irrigation is available, pear orchards are largely maintained in a permanent cover crop or sod. Alfalfa is most widely used for this purpose, although there is increasing interest in sweet-clover. Where such a system of culture is used, the area between the trees is seeded to the cover crop, preferably before the trees reach full bearing age. The crop is allowed to grow throughout the season, matting down to form a dense soil cover during the late summer. The usual practice is to disk such orchards in the spring, working the ground thoroughly to incorporate the vegetation from the cover crop in the soil. Irrigation in these districts is almost entirely of the furrow method. After the spring disking, furrows are opened for the summer irrigation. The disking also holds the growth of the alfalfa in check during the period in the spring when the trees bloom and when growth of the trees is most rapid. Thus the competition between the cover crop and

the tree is avoided during the critical period. Following the disking, however, the alfalfa soon begins to grow, and a heavy soil cover is secured by midsummer.

This system of orchard management represents the minimum cost for cultivation and provides a steady supply of organic matter for the soil. The soil is shaded and is several degrees cooler throughout the season with the cover crop than where clean cultivation is practiced. The incorporation of organic matter, the minimum cultivation used, and the penetration of the roots of the cover crop, all aid in keeping the soil in satisfactory condition to take up the water readily. The disadvantages of the system of management are that somewhat more moisture is required than under clean summer cultivation. Also, the heavy growth of vegetation tends to harbor certain insect pests. This may require occasional seasons of clean cultivation.

Sweetclover has apparently been somewhat superior to alfalfa in opening up impervious soil, probably because the crop planted is a deep-rooted biennial. The dying and decay of the roots at the end of the second season's growth tend to open up impervious subsoils to an unusual degree. The top growth of the sweetclover, however, is so vigorous and upright that it may require dragging down to facilitate other orchard operations.

In districts having less abundant water supply the use of permanent cover crops in the orchard has not become general. In the Rogue River Valley district of Oregon and in practically all districts of California clean culture throughout the summer months is practiced. There the orchards are usually plowed in the spring and the soil worked down thoroughly. Shallow cultivation is usually given to the land following each irrigation. Where irrigation is not practiced, disking or other shallow cultivation is frequently practiced throughout the spring and summer to keep down native vegetation that would rob the soil of moisture needed by the trees.

In the soils of relatively heavy texture, which are often used for pears, the time for spring plowing is particularly important, especially in nonirrigated orchards. If such soil is worked before it dries sufficiently, it will dry into hard clods and remain in poor physical condition throughout the summer. If the soil is too dry it is also difficult to pulverize it satisfactorily. If a winter and spring cover crop is growing in nonirrigated orchards it is particularly important to work down the cover crop before the soil has become too dry.

In districts where permanent cover crops are not used it is a common practice to seed annual overwinter crops in the late summer. Among those most widely used are vetch, horsebeans, native legumes, and grain. In many orchards cover crops are not seeded, but an abundance of native vegetation develops in the fall after cultivation has ceased. This native vegetation is very helpful in maintaining the organic supply in the orchards. In most parts of California growth of cover crops or of native vegetation will occur during the winter months. In the northern districts the winters are too severe to permit much growth of cover crops except in the fall and early spring.

FERTILIZATION

In most districts of the Pacific coast, pears, in common with most other orchard fruits, give the greatest response to nitrogenous fertilizers. In practically all of the districts of Oregon and Washington, and in some sections of California, annual applications of fertilizers high in nitrogen stimulate the growth of the trees and improve production. On some of the deep, fertile, alluvial soils, particularly where the orchards are maintained under summer cultivation, little response from fertilizers has been obtained. Where fertilizers have proved of value, those high in nitrogen have generally been most satisfactory. Annual moderate applications, usually made in the late fall, have proved very satisfactory.

POLLINATION

The setting of fruit by all important pear varieties is aided by cross-pollination under some if not all conditions in the Pacific States. In some localities, especially in the Sacramento Valley district and near Clearlake, Calif., good crops of fruits are harvested in large orchards of the Bartlett variety where no provision is made for cross-pollination. However, many growers believe that heavier crops could be obtained some years if pollination were provided. That cross-pollination is advantageous to setting fruit of practically all varieties is now generally conceded. Provision for cross-pollination should be made, notwithstanding the fact that such varieties as Bartlett, Anjou, and others may, under favorable conditions, set fair crops when planted alone.

In providing means for cross-pollination, the interplanting of commercial varieties in alternate rows is often practiced. If a greater number of trees of one variety than of the other is desired, two or three rows of one may be planted to each row of the pollinizer. If the variety considered to be the best pollinizer is planted solely or chiefly for its benefit to the other variety, single trees may be planted at intervals throughout the orchard. One tree is considered sufficient to pollinize eight others if bees are provided to carry the pollen. The best distribution of these trees is made by planting a pollinizer in every third tree space of every third row. Another method for providing fertilization for self-sterile blossoms is by top-grafting a branch of the tree with scions from a pollinizer. This method is practiced when a solid block of one variety has been planted and the grower does not wish to remove trees to make room for planting others for pollinizers. It is obviously less desirable than interplanting, as the fruit of the individual branch will need to be harvested separately and may need other special handling.

Experimental evidence reported in California Agricultural Experiment Station Bulletin 373, Pear Pollination, and Oregon Agricultural Experiment Station Bulletin 239, Pollination Study of the Anjou Pear in Hood River Valley, indicate that varieties should be interplanted to provide a means of cross-pollination. From the results obtained in California it appears that the Bartlett may be successfully used as a pollinizer for most of the other important varieties, including Anjou, Bosc, Comice, Hardy, Howell, Easter Beurre, and Winter

Nelis; that in the Sierra Nevada foothills Bartlett is almost entirely self-sterile, and that Winter Nelis is a good pollinizer for Bartlett. The tests made in the Hood River Valley demonstrated the desirability of cross-pollination for Anjou under those conditions. Bartlett, Easter Beurre, and White Doyenne were found to be effective pollinizers for Anjou. The bulletins cited present information on pollination that will be of value to pear growers.

PRUNING

Pruning is recognized as an important cultural operation in the production of regular crops of large-sized pears typical of the variety in shape and quality, as well as in the production of most other cultivated fruits. It is also one of the most difficult problems confronting the grower. The influence of the growth condition and the differences in characteristics of growth and production among varieties may all influence the type of pruning in a given orchard. A careful study of varietal characteristics and the influences of local conditions and treatments on them is necessary in evolving the best pruning system.

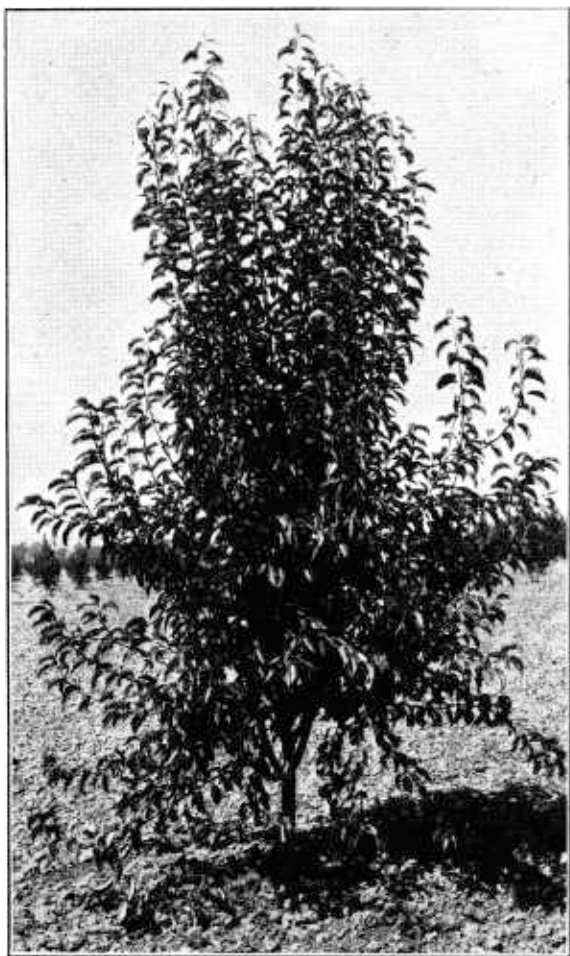


FIGURE 13.—Three-year-old Bartlett tree on which drooping branches have been left to shelter the trunk from the sun. (Kelseyville, Calif., photographed in August.)

PRUNING THE YOUNG TREE

In the new orchard the problem of shaping the tree and protecting the trunk and branches from the sun is encountered (fig. 13). It is desirable to secure the best possible distribution of branches along the main trunk. If the nursery tree being planted is an unbranched whip, this can be done by cutting off the tree at the height desired

for the topmost main branch, usually 40 to 48 inches. With vigorous trees a large number of branches will form along the trunk the first season, the selection of scaffold branches to be made from these after the first growing season is over.



FIGURE 14.—High-headed Bartlett pear tree injured by sunburning and sunscalding following freezing weather. Sunscald injuries on this tree have been bridge-grafted. (Vancouver, Wash., photographed in August.)

In pruning at the end of the first year, four or five vigorous branches 6 to 12 inches apart along the trunk and well distributed around it should be selected for the main scaffold branches and the

other limbs removed. It is preferable that the leader or top branch be somewhat stronger growing than the lower branches, as this forms the leader of the tree, and stronger crotches result if the side branches are smaller than the trunk from which they rise. Unless the tree has made excessive growth, no heading back of these branches is necessary. Such a distribution of branches gives a stronger tree, reduces the danger of sunburn injury (fig. 14), and reduces the danger from blight to the tree as a whole.

Following the first season and up until bearing age, the pruning that the tree should receive will vary somewhat with its growth. The less pruning, the more quickly the tree will come into bearing. Consequently, once the main branches are selected, a minimum of pruning should be given until the tree is in bearing. Usually a light thinning out of branches will suffice. If the growth is very strong, heading back the branches lightly for a year or two will give a more compact tree that will stand more stiffly in the wind. Heading back

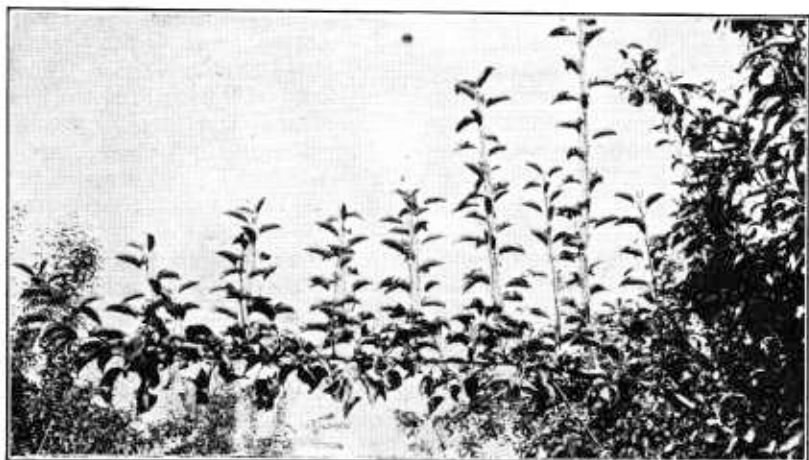


FIGURE 15.—This 2-year-old Bartlett branch was tied down to this position in winter. The new growth is typical of that on branches so treated. (Photographed in September.)

from the second year until the trees are in heavy bearing should generally be avoided. Four or five main scaffold branches are usually sufficient to build a good tree. With varieties susceptible to blight and where it is likely to be serious, it is advisable to leave more framework and secondary branches, as infection from this disease may make it necessary to remove some of them.

As the trees approach bearing age, corrective pruning may be necessary to secure a satisfactory fruiting condition. Most young trees make an upright growth and do not branch freely. Admitting light to the center of the tree, which is sometimes accomplished by spreading the tree by mechanical means, encourages the formation of fruit buds. An effective means of spreading the trees mechanically for early production which has been practiced in a few orchards is to bend down and tie the branches either to the trunk or to stakes driven into the ground (fig. 15). The branch that is tied down will develop numerous twigs and spurs and generally will become fruit-

ful. This method of inducing early fruiting has been rather successful. Placing spreaders between the branches to hold them apart and thinning out some of the branches if they are close together will also be helpful in inducing fruitfulness. Once the tree is in moderately heavy production, the weight of the fruit is usually sufficient to keep it satisfactorily spread.

PRUNING THE BEARING TREE

In the young tree the basic principle in pruning should be to build a suitable framework with the least possible amount of cutting and to handle the tree so as to get maximum size and production at an early age. After the tree has come into full bearing, however, different factors prevail. The purpose of pruning the bearing tree is to maintain the fruiting wood in vigorous condition in order that the trees may produce regular crops of fruit of good size and quality. In order to secure regular heavy production of fruit of good size and quality it is necessary that the fruiting spurs be maintained in vigorous growth. Pruning tends to reduce the number of fruiting points, but stimulates more vigorous growth in those that remain. In general, the minimum amount of pruning that will maintain the spurs and fruiting wood in vigorous growing condition will give the most satisfactory results. Consequently, the pruning practices for the bearing tree should be closely correlated with soil management practices, including irrigation, fertilization, and cultivation, and with the thinning of the fruit crop.

Pear varieties may be classified into two groups, according to their bearing and growth habits. In one of these groups there is a strong tendency to develop and retain spurs throughout the tree. These varieties tend to produce little new growth except at the terminals of the branches and near points of pruning. Hardy and Lawson are samples of varieties that produce great numbers of spurs but tend to produce little new wood along the older branches. Other varieties having this tendency, though to a less-pronounced degree, include Bosc, Clairgeau, Koonce, Flemish Beauty, and, to a still less extent, Anjou and Comice.

Another group of varieties tends to produce twigs and vigorous shoots not only from the terminals of the branches but along the sides of the branches as well, if conditions are favorable for wood growth. Development of spurs in these varieties is much less marked. Bartlett and Winter Nelis are outstanding examples of varieties having this growth habit; P. Barry, Glou Morceau, For-elle, and Easter Beurre would also be considered in this class. All varieties of rather low vegetative vigor tend to develop large numbers of spurs rather than to throw out the longer type of vegetative growth.

Varieties having a pronounced tendency to form spurs generally will require rather heavy and detailed pruning to maintain the spurs in a vigorous fruitful condition. The heading back of branches and new shoots to maintain the vigor of the fruiting branches and to induce growth of new branches, also the thinning out of old fruiting branches and spurs in order to maintain vigor on those that are left, are essential in such varieties.

With the varieties that have a greater tendency to form shoot growth it is generally necessary that the shoots be thinned, in order to keep the trees sufficiently opened to the light and to maintain sufficient vigor in the new growth. Moderate annual pruning on practically all bearing varieties seems desirable to maintain the trees in the best fruiting condition. In general, pruning in pear trees should be detailed and distributed over the whole tree, as the greatest response in increased vigor comes in the part of the tree adjacent to the pruning cuts.

If soil-fertility and soil-management practices are such that the trees can be maintained in a fairly vigorous condition, satisfactory results can be obtained with only a limited amount of cutting. If the pruning is reduced too much, however, it is difficult to secure adequate size of fruit even with fairly heavy fruit thinning. Over-pruning, on the other hand, reduces the bearing surface and the leaf area of the trees so much that production is likely to be decreased. A balanced program of moderate annual pruning, together with good soil-management practices, will generally result in maximum production of fruit.

In all sections where pear blight is a serious menace the danger of inducing a vigorous growth that will be very susceptible to blight must be considered. Only the heading back and the thinning out necessary to enable the tree to make a moderately thrifty growth and produce fruit of the desired size should be undertaken; unnecessary cutting that will result in a heavy new growth should be avoided. In general, the wood of the pear tree is very tenacious of its vigor and will withstand abuse in pruning or endure neglect at pruning time with less permanent injury than will many other fruit trees.

FRUIT THINNING

Many varieties of pears tend to set heavy crops of fruit which the tree is unable to develop to good marketable size. This is particularly likely to occur with such varieties as Winter Nelis, Bosc, Bartlett, and occasionally with Anjou. If medium- to large-sized fruit is desired, it is necessary to thin part of the crop from such trees, in order to have a larger leaf area per fruit. In California, Bartlett thinning is seldom necessary.

Many pear varieties, such as Bartlett, Hardy, and Bosc, tend to set the fruit in clusters, often three to five fruits setting on a single spur. If the set of fruit on the tree as a whole is excessive, these clusters should be reduced to one or two fruits each. On the other hand, if the set of fruit on the tree as a whole is not excessive, fruit on these clusters will reach satisfactory size and quality without thinning.

It is impossible to lay down hard and fast rules for the thinning of pears. The number of fruits a tree will carry and develop to good marketable size will vary with the vigor of the tree and with the growing conditions. Experiments indicate that, with nearly all varieties, from 30 to 40 good leaves per fruit are essential for the building of the materials that go to make the fruit. These leaves, however, need not be directly adjacent to the fruit. With extremely heavy sets of fruit, thinning to reduce the amount of fruit in proportion to the leaf system is essential if fruit of best size and quality is to be obtained.

Under present standards larger sized fruit is required for canning than for fresh market purposes. If the crop is intended primarily for cannery use it is particularly essential that fruit of good size be secured.

PEAR HANDLING AND STORAGE

Since pears, both for fresh shipment and for canning, are harvested prior to becoming tree-ripe, the question of the state of maturity at which they are picked is very important. If they are harvested too early, the quality is poor; if they are allowed to become too mature on the tree the storage life is shortened, and many varieties tend to break down at the core while still sound at the surface. Numerous investigations to determine the proper picking maturity of pears and the best methods of handling following harvest have been conducted. United States Department of Agriculture Technical Bulletins 140, Investigations on the Handling of Bartlett Pears from Pacific Coast Districts, and 290, Investigations on Harvesting and Handling Fall and Winter Pears; California Agricultural Experiment Station Bulletin 470, Maturity Standards for Harvesting Bartlett Pears for Eastern Shipment; Oregon Agricultural Experiment Station Bulletins 228, Investigations on the Harvesting and Handling of Bosc Pears from the Rogue River Valley; and 254, Further Investigations on the Harvesting, Storing, and Ripening of Pears from Rogue River Valley, discuss in detail the problems of pear harvesting and handling.³

INSECTS AND DISEASES

Several insect pests and diseases cause serious losses in commercial pear orchards in the Pacific Coast States. Fire blight, scab, and black end are the most serious diseases, while the principal destructive insects are the pear-leaf blister mite, codling moth, pear thrips, and red spiders. Familiarity with the performance of the insect or disease in the locality where the orchard is situated is necessary, as success depends upon the precision used in choosing the time for the application of control measures, as well as upon the thoroughness of the application of the remedy. The State experiment station or county agricultural agents should be consulted for specific instructions as to control practices in the various districts.

INSECTS

Pear Leaf Blister Mite and Bud Mite ⁴

Injury to both leaf and fruit is caused by pear leaf blister mite and bud mite, but good control may be expected to follow a thorough application of lime-sulfur when the buds are beginning to swell in the spring.

³The two U. S. Department of Agriculture bulletins may be purchased from the Superintendent of Documents, Washington, D. C., for 10 and 15 cents, respectively. Persons desiring copies of the other publications should communicate with the State experiment station publishing them.

⁴*Eriophyes pyri* Pgst.

Codling Moth ⁵

The codling moth is abundant in all pear-growing districts of the Pacific Coast States and causes heavy loss to almost all pear growers. In addition to the loss of fruit that is made unsalable by the moth is the expense of spraying for its control and of removing the spray residue from the fruit. Arsenical sprays are mainly used for codling moth control. There are two or more distinct broods of codling moth in the Pacific Coast States, but these emerge at different times in different localities, depending on season variation. The local county agent should be consulted regarding dates for applying sprays and materials to use.

Pear Thrips ⁶

Pear thrips are very destructive insects that injure the opening blossom clusters and blossoms. They may be controlled by spraying, as the buds are opening, with an oil emulsion or a miscible oil at a strength of 2 gallons in 100 gallons of water, to which should be added 1 pint of nicotine sulfate (40-percent nicotine). The nicotine may also be used with lime-sulfur if that material is used for scab control, in which case the oil should be omitted.

Red Spiders ⁷

Several species of red spiders or mites often cause much injury to pear leaves. They are most numerous in orchards in dry, hot localities where irrigation is not practiced or where it has been neglected and the soil allowed to become dry. The eggs of certain species of these mites may be killed with a dormant-strength oil emulsion or lime-sulfur applied late in the winter when the buds begin to swell, and all of the species may be controlled by the application of sulfur materials or summer oil sprays when the first mites appear in the spring. Prompt and thorough treatment is important.

DISEASES

Blight

Blight, caused by a bacterium, is by far the most destructive disease that attacks pears. It is prevalent in most of the important pear-growing sections of the Pacific Coast States.

The disease usually appears first as a blossom blight, later spreading to shoots. Blighted blossoms and the leaves of blighted shoots turn brown, then black, and remain attached to the tree. From blighted blossoms and shoots the disease may enter the trunk and main limbs, causing cankers in which the bacterium may live over winter and act as a source of infection for the next season. Control consists of the removal of all infected spurs and branches as soon as they appear and of the removal of affected areas on the large branches, crotches, trunks, and roots during the dormant season. In all this work cutting tools should be disinfected so as to prevent transmitting the disease. In localities where blight is a menace, weekly visits to every tree should be made during the spring and

⁵ *Carpocapsa pomonella* L.

⁶ *Taeniothrips inconsequens* Uzel.

⁷ *Tetranychus telarius* L., *Paratetranychus pilosus* C. and F., and *Bryobia praetiosa* Koch.

summer by someone experienced in blight control. Helpful preventive measures consist in removing all root suckers and succulent water sprouts on the body of the tree in fall or winter and employing cultural and pruning practices that oppose vigorous wood growth. State experiment stations and county agricultural agents should be consulted from time to time in regard to the most modern methods of control of blight, as many experimenters are working on the subject.

Scab

Scab is a fungus disease that appears as dark, moldy patches on both fruit and leaves. It often causes heavy reduction in yield and serious defoliation in districts having considerable spring rainfall. Spraying, (1) when the winter buds first show individual flower buds, (2) just before the first flowers open, (3) directly after petal fall, and (4) 3 weeks later, is recommended for controlling scab. Bordeaux mixture or lime-sulfur (summer strength) are recommended generally, but on certain varieties that are severely injured by these sprays, one of the milder sulfur sprays should be used. For specific directions on spraying, experiment stations of the State or of the United States Department of Agriculture should be consulted. Removal or plowing under of the fallen leaves in winter or early spring is an aid in control.

Black End

Black end is a term applied to fruits that become hard, rounded, or often black over the blossom end as they approach maturity. The trouble occurs almost exclusively on trees propagated on oriental stock (pp. 21, 22). No satisfactory control measure has been found, but the trouble may be avoided by using seedlings of the French pear for rootstocks.

PRINCIPAL PEAR VARIETIES IN THE PACIFIC COAST STATES

ANJOU

The Anjou is a pear of French origin and has been grown in the Pacific Coast States over a long period, though most large plantings have been made during the last 25 years. The Anjou is found in limited quantities in some of the pear-growing districts of California, but has become an important variety in Washington and Oregon. It is prized because it keeps well in storage and may be marketed over a long period. The fruit is of good size, high in dessert quality, and very attractive. The tree is vigorous and reaches large size (figs. 10 and 11) and is the most resistant to blight of any of the large, high-quality varieties. It is considered a good and consistent bearer after it reaches bearing age, but is very slow in coming into production. The Anjou is harvested about midseason among the fall and winter varieties, but if carefully handled may be held in cold storage until April.

A peculiarity of the Anjou is that blight infection in trunk and crotches is much more common in comparison with twig and branch infection in it than in the other varieties. Although but little if any blight may be found in the shoots on small branches, the search for

infection in the crotches, which if left untreated would soon do serious damage, must not be neglected.

BARTLETT

In all principal pear-growing districts of the Pacific States, with the exception of the Rogue River and the Hood River valleys, the acreage of Bartlett is considerably greater than that of all other varieties combined, and in most localities it is still a favorite for planting.

The trees are adapted to a wide geographical range and to a great diversity of soil and climatic conditions. They are prolific, bear regularly, and endure neglect, abuse, and uncongenial surroundings surprisingly well. These tree characters, combined with the quality of the fruit and the uses in which it may be employed, give the Bartlett the rank of a truly remarkable fruit. Its susceptibility to blight, however, causes it to be condemned by many growers even if they are forced by its good qualities to continue to plant it. The high standard of the variety is such that a Bartlett tree that has been killed by blight is usually replaced by another Bartlett, and orchard extensions are usually made by planting trees of this same variety. As with other varieties, sufficient coolness in summer will shield it from blight, but high temperatures are desirable to obtain fruit of the highest quality.

Where well grown, the Bartlett is generally considered the standard of excellence by which other pears for fresh shipment are measured. It is the only variety in the West to be used for all purposes. In flavor and texture it is unsurpassed among the large-fruited, commercially grown pears in the Pacific States. It is the first of the important commercial varieties to ripen, the picking season ranging from early July in the valleys of central California to late August at the high elevations in California and in the northern districts.

The Bartlett fruit may be held successfully up to 2 months in cold storage. Fruit of this variety is normally off the fresh markets by the middle of October. The Bartlett reaches its highest perfection, both in dessert quality and in storage and handling quality, when grown under fairly hot summer conditions. In the coastal districts of all the Pacific States, where summers are very cool, the fruit does not keep as well following harvest and usually is less rich in flavor than in the hotter interior districts. Fruit from these coastal districts is usually canned or consumed locally, as the carrying quality is not sufficiently good to allow shipment to distant markets.

BOSC

Like the Anjou, the Bosc has attained most of its popularity on the Pacific slope during late years and in the pear-growing districts of Washington and Oregon. It is not now a favored variety for planting. The largest acreage of this variety is to be found in the Rogue River Valley of Oregon, where the fruit attains a high degree of perfection. Upward of 1,000 acres are planted in central California.

The fruit grows to good size, and the yellow skin, which is almost covered with a brown russet, is particularly attractive. It is con-

sidered a fall and early winter fruit, reaching prime market condition in October and November. It ripens a little after the Bartlett and before the Anjou. The tree comes to bearing fairly early and bears regular and heavy crops.

The Bosc tree, particularly while young, is difficult for the pruner to manage. The branches produce vigorous new shoots from their terminals; these remain rather slender for a considerable time and branch but little, so that the tree remains open and often becomes ungainly and willowy by the spreading of the slender branches.

Special attention is required to maintain a tree of desirable shape. Trees of this variety are attacked by blight about as seriously as trees of any of the other principal commercial varieties and are somewhat less tolerant of poor soil drainage than those of many varieties.

CLAIRGEAU

The Clairgeau is being planted but little at present, as the fruit, although large and attractive, is coarse in texture and second-rate in flavor when compared with the best varieties. It has a storage season of only 2 to 3 months. Clairgeau trees are found in a number of older orchards in the San Francisco Bay district and in other localities in the cooler seacoast valleys of California. The tree grows well, and so far as pruning is concerned is one of the easiest trees to manage. The old branches have sufficient vegetative vigor to maintain thrifty and productive spurs, and these make considerable annual growth and branch freely for many years. The new-shoot growth is largely from the terminals of the branches. The growth of the spurs makes rather compact branches, but the sparse branching at the terminals of the limbs permits an abundance of light to enter; therefore, by heading back the new terminal shoots it is easy to keep the tree sufficiently open and of the desired shape.

HARDY

The Hardy is known by the two uses to which the tree is put—producing fruit and grafting on quince root as an intermediate stock on which to graft other varieties. It is used for both of these purposes in California, although the use of quince stock is limited. This variety is not very generally planted, but near San Francisco Bay and in the cooler portion of the Santa Clara and San Juan Valleys it has been a popular variety for some time. The fruit is of good size and of attractive shape, keeps and handles fairly well in storage, and attains an attractive flavor. It ripens soon after the Bartlett and before the Bosc and the Anjou. It is a favorite for export on account of its relative earliness, coupled with a carrying quality much superior to that of the Bartlett.

The Hardy tree grows well, is a heavy bearer, and appears to be more resistant to blight than the Bartlett. It is rather easily handled by the pruner, for, although it is a strong grower, it is not inclined to branch too freely, so that the tree remains open. Much of the new growth takes place at the terminals of fruiting branches or where branches are headed back or removed. Numerous large fruiting spurs instead of shoots develop along the fruiting branches and remain vigorous and productive for many years (fig. 16).



FIGURE 16.—Some 12-year-old spurs on secondary branches of a Hardy pear tree. This tree is on quince root and is growing in deep, fertile, irrigated soil. It bears good and regular crops. (Santa Clara, Calif., photographed in April.)

COMICE

In the Santa Clara Valley of California and the Rogue River district of southern Oregon the Comice is grown to some extent, although it is one of the minor varieties in both acreage and production. It is usually found in the older plantings but has been planted little during recent years because of its failure to bear heavy crops consistently. The Comice tree is open and rather easily managed by the pruner but is not as consistent in bearing habits as many other varieties. The fruit is large, light greenish yellow in color, and of excellent dessert quality. In flavor it is among the very best of the pears. It keeps well if handled carefully, but is one of the most easily bruised among the commercial varieties. The skin is tender and easily punctured, and even light bruises at picking time will result in darkened areas on the fruit. It is also readily injured by the rubbing of leaves and branches.

EASTER BEURRE

Among the pear varieties grown on the Pacific slope, the Easter Beurre is one of the latest to ripen. The trees are heavy producers, and the fruit keeps and handles exceedingly well, holding until May in cold storage if carefully handled. For these reasons the variety is retained. The coarseness of the fruit and the rather unattractive green color, which is often patched with russet, prevent much extension of its planting. The fruit is large and prized for baking. The tree is more resistant to blight than most varieties and grows to large size. Easter Beurre is sometimes grown as a pollinizer for Winter Nelis.

FORELLE

The Forelle is a late fall variety which is grown only sparingly because of its susceptibility to blight; it is probably less resistant than any other of the commonly grown varieties. Limited plantings in the rather cool Santa Clara Valley of California, where blight is not a serious menace, have proved satisfactory. Although the trees do not grow to large size, they bear regularly and well. The speckled fruit with its greenish-yellow skin and brilliant red cheek is very attractive. It is juicy and has a pleasing flavor.

GLOU MORCEAU

In the San Francisco Bay district and other coastal valleys of central California the Glou Morceau is still grown to some extent, although it is seldom planted at present. It is not considered as profitable as most other late-ripening varieties. Its cold-storage season extends until early spring. The tree is a good grower. The greenish-yellow fruit, although smooth, is not particularly attractive, but it is juicy, of a smooth tender texture, and of good flavor. Deformed fruits are common with this variety; in some years large quantities of fruit are thrown out as culls from this cause.

WILDER EARLY

Fruit of the Wilder Early is ready for shipment about 2 weeks to a month before the Bartlett and is one of the best of the early pears. The fruit is small, but the red cheek and yellow skin make it attractive. The tree grows rather slowly and remains open, as there is little

branching. There is a decided tendency to alternate bearing, the trees producing excessive crops one year and remaining almost fruitless the following year. Usually not all trees in the orchard produce their crops the same year, however. On bearing spurs of the Wilder Early the leaves are usually small, whereas those on trees that are not bearing are of good size and shape.



FIGURE 17.—Winter Nelis pear tree growing in deep, fertile, irrigated soil. The photograph was taken before the annual winter pruning. (Santa Clara, Calif., December.)

Wilder Early is not much grown, but may be found in numerous localities in the warmer pear-growing valleys of California and occasionally in the Sierra Nevada foothills.

WINTER NELIS

The Winter Nelis is the most widely distributed variety of winter pear on the Pacific coast, although the acreage devoted to it is not increasing nearly as fast as that of the more popular early winter and winter varieties, Bosc and Anjou. It has been more favored in the Santa Clara Valley of California, the Rogue River Valley of Oregon, and the Yakima Valley of Washington than elsewhere. Only a very limited acreage of it is found in other districts, largely because of the failure of the fruit to reach the desired size.

The fruit is attractive with its greenish-yellow color and large areas of heavy, dark-brown russet that sometimes entirely cover the fruit. The flesh is tender and juicy, and in flavor it is among the very best of

the pears. It is also one of the best pears for storage purposes. When placed in cold storage as soon as picked, it will keep until well into the following spring.

Young Winter Nelis trees present a difficult problem to the pruner, both in the nursery and the orchard. The young shoots make a thrifty growth but lack the tendency to form symmetrical trees, become tangled or drooping, and are difficult to manage. The tree attains a large size, but it needs a better soil than some varieties to produce fruit of good marketable size. It is prolific, and unless the fruit is thinned it is likely to be small. Desirable sizes of fruit are usually obtained from trees growing in deep fertile soil if given sufficient irrigation and pruned rather heavily (fig. 17). As new shoots are produced in considerable number and are rather slender, much thinning out is needed at pruning time, and also some heading back of the remaining shoots is often required to maintain the vegetative vigor necessary for the production of large fruit. It is claimed that light crops of this variety have sometimes been due to faulty pollination. The Easter Beurre is considered a good pollinizer for it and is sometimes grown for that purpose. In its resistance to blight, Winter Nelis is somewhat superior to the Bartlett.

THE FUTURE OF PEAR GROWING IN THE PACIFIC COAST STATES

The high quality of the fruit produced, coupled with the heavy and dependable production, assures the permanency of the pear industry in the Pacific coast region. The pear acreage increased rapidly between 1920 and 1930, however. Since 1930 a considerable number of orchards on unsuitable soils or with unsatisfactory rootstocks have been pulled. Much of the recent planting is on land well adapted for the purpose, so the present annual production probably will be maintained for a good many years to come. Pear orchards, where well located and well cared for, are long-lived; many orchards more than 50 years of age are still producing large crops of high-quality fruit.

Considering these factors, extensive increase in the present pear acreage seems undesirable. The present production is sufficient in normal years to provide about all the fruit the market can utilize, particularly of the summer and early fall varieties.